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ABSTRACT

A basic biology course, Fundamentals of Biology, was used as a sample course with which to measure the effectiveness of a multidisciplinary approach using three different teaching modes: audio-tutorial, a local public broadcasting station's television presentation, and a straight lecture presentation. The results and rationale of the experiment are discussed. (SGM)

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RESEARCH IN INSTRUCTIONAL METHODS

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JC 740 177

Fundamentals of Biology is a freshman level college course aimed at both nonmajors and majors of biology. The ideas of biology are presented in the framework of our cultural heritage as well as a scientific body of knowledge. The objective of all general education courses is to afford the students a broad background in all fields, so that their specific area of interest is viewed in proper perspective to all other branches of learning. Today, every citizen is required to make decisions with biological implications. Without a firm grounding in biological principles, these decisions may not be wise ones. For this reason, we feel every educated person should be introduced to the Fundamentals of Biology.

For the student planning to major in biology, it is even more imperative that a general overview of the discipline be presented before he begins to specialize in some narrow area. This student needs to know where his ideas fit into the informational patterns of the discipline. It is only in a fundamentals course that the unity, rather than the diversity of living things, is stressed.

In this course, a multidisciplinary approach is used. Facts are presented as evidence for theories. Ideas are introduced in historical perspective. The construction of model systems and the hypothesis-prediction mode of problem solving are emphasized throughout. By the end of the course, the student will be on speaking terms with the concept of a unified biosphere and should be cognizant of the ramifications of human activity on the functioning of that biosphere. The scientific news in the popular press should not mystify him; nor should it mislead him. If he is going on to further studies in biology, he will be conversant in the language and the principles in the major segments of biology.

Three different modes of teaching have been utilized to accomplish these aims: the audio-tutorial approach, a television presentation aired by the local public broadcasting station and straight lecture. The course was originally established in the audio-tutorial mode and is described as follows in the catalog:

> Fundamentals of Biology - BIO 103 - includes cell structure and processes (both physical and biochemical), mitosis, gametogenesis, some aspects of embryology, genetics and evolution. In this course, tape sessions, large assembly sessions and conferences replace the conventional classroom lectures.

In his paper New Concepts in Education and Learning Theory, Ralph Tyler lists several conditions for learning:

1 & 2. The learner carries on the behavior he is to learn and obtains satisfaction from it.

3. The student must be actively involved.

4. The student needs to have clear models of behavior to guide him.

5. The student must have materials to work on.

6. The student must have time to carry on this behavior, to keep practicing it.

7. There should be an opportunity for a good deal of sequential practice that goes more broadly and deeply with each subsequent practice.

8. It should be possible for the student to set high standards of performance for himself.

9. The learner must have a means for judging his performance to be able to tell how well he is doing.

BIO 103 is an attempt to fulfill these criteria.

Because of the wide variation in the backgrounds of the students, a taped tutor serves individual differences well. The students are expected to listen to one tape a week. They may advance to subsequent tapes or they may review previous ones. Each tape is designed to occupy approximately 50 minutes for the conscientious student with no background in the subject. Although the tapes are intended to replace the lecture, certain elements of observation labs are also incorporated: 2 x 2 slides, film loops, reprints, texts, demonstrations and displays. Several tapes are supplemented by programmed texts from EMI (Educational Methods, Inc., Chicago.) Each tape is accompanied by a study guide which contains a list of the behavioral objectives and an outline of the important information on the tape.

The large assembly session is multi-purpose. Traditional lectures, which introduce or summarize material, or films reinforce the information on the tapes. Exams for each unit are administered in this period, also.

Quizzes on the material covered each week are given in conference sessions. These sessions are set aside for question and answer periods and an effort is made to keep the group small.

The television course grew out of the A-T course as a result of an effort to reach a community of students that were unable to attend classes at our plant. The local public broadcasting station had been airing canned shows from Chicago College of the Air and SUNY for a consortium of colleges in the Baltimore area and it was established that such a community existed between WMPB and Catonsville Community College because it lent itself to color presentation and many visuals had already been collected. The course objectives remained the same. Students viewing the lessons at home were invited to call the coordinator for their college during a telephone hour following each broadcast. On-campus review sessions and examinations were given at the various colleges at the end of each unit.

Student critiques indicated that some students would prefer the standard lecture approach. Some instructors opted for this approach also.

The lecture approach used three hours per week of straight lectures. The study guides which are handed out to students in the A-T approach are also given to these students. The lecturer follows the same sequence so that the student can fill in the guides in the same way he would if he were

listening to the taped lecture.

The same 2 x 2 slides that are used in the carrel are shown on the lecture hall screen. Additional slides are used as needed to illustrate the lecture material. Review of the behavioral objectives precede the unit tests. The same unit tests and final are used in the lecture approach that are given in the A-T approach.

It was decided that an experiment should be conducted to determine if the mode of instruction affected the accomplishment of the objectives of the course. A research group was established consisting of members from the biology staff and the Coordinator of Institutional Research.

The purpose of this study was two-fold:

- To determine the effect of three teaching methods (audio-tutorial, lecture and television) on achievement by community college students in a one-semester, fundamentals of biology course and,

- To determine the effect of student choice of teaching method (audio-tutorial or lecture) on achievement in a one-semester, fundamentals of biology course.

Students enrolled in the Fundamentals of Biology course at Catonsville Community College during Fall 1972 were the subjects of this study. With the exception of those students who enrolled in the course section taught by television, most students did not know at the time of registration whether their course section would be taught by the audio-tutorial or lecture method. A total of 121 students were enrolled with 65 in the audio-tutorial, 45 in the lecture section and 11 in the television section.

Each of the sections was taught using a common course syllabus, however, because the sections were taught by different faculty members, some fluctuation in content was anticipated. By not controlling for the effects of the personality of the instructor, this study is limited to less than the preciseness of a controlled laboratory situation. Although this limitation precludes the generalization of these results, it did provide for the design of a study which fit our, and probably other college's needs. Specifically, each of the participating faculty were using the teaching method which they preferred and were faculty members who were expected to remain with the institution. Thus, if a student chose the lecture method, the instructor would be a certain professor and, so forth for each of the teaching methods. If a controlled situation had existed and one teaching method had appeared to be superior to the others, it might well still have not been a superior method when taught by another instructor, particularly if that instructor did not favor that method.

Because enrollment in course sections was student selected, it was necessary to determine if the three groups of students were similar in terms of ability. General ability was measured by high school average and scores obtained on the American College Testing program. A one-way analysis of variance was computed and there were no significant F's obtained. (A .05 level of confidence was required for significance to be obtained throughout this study.) Thus, there were no significant differences in the general ability of students among the three groups. The results of the analysis appear in Table I.

TABLE 1. Descriptive Statistics

Variables		Teaching Method: Audio-Tutorial	Lecture	T-V	Total	F Ratio
High School QPA	$\bar{X}$	2.18	2.23	2.26	2.21	
	s.d.	0.66	0.55	0.76	23.84	.11 NS*
ACT						
English	$\bar{X}$	16.60	15.31	13.75	15.96	
	s.d.	5.12	5.36	3.83	163.78	1.05 NS
Math	$\bar{X}$	18.42	18.67	16.75	18.45	
	s.d.	6.33	5.79	2.28	189.21	.18 NS
Social Science	$\bar{X}$	17.96	18.10	14	17.85	
	s.d.	6.29	6.10	6.20	104.53	.78 NS
Natural Science	$\bar{X}$	20.21	18.90	18	19.58	
	s.d.	6.08	5.45	4.95	199.24	.71 NS
Composite	$\bar{X}$	18.43	17.90	15.75	18.10	
	s.d.	5.10	4.38	3.11	182.57	.64 NS

* NS, not significant at the .05 level of confidence.

Ability in or prior knowledge of biology was also measured upon entry by a test designed to relate specifically to the course content -- fundamentals of biology. There were 70 items and the test was multiple choice. The test achieved moderate to good reliability. The Kuder-Richardson 20 formula yielded a reliability of .645. Face validity of the test was determined in its creation by directly relating the items to the course content.

A one-way analysis of variance was computed and there were no significant differences among the three groups of students on prior knowledge of biology.

TABLE 2. Fundamentals of Biology Pre-test Scores

	Teaching Method: Audio-Tutorial	Lecture	Television	F Ratio
$\bar{X}$	27.26	26.18	31.09	2.82 NS
s.d.	6.77	4.85	6.23	

Because there was no significant differences among the groups of students in terms of general ability and prior biology knowledge, it may be assumed that any differences occurring in biology knowledge measured at the close of the semester are primarily the result of the teaching method as utilized by a specific instructor.

In order to determine the effects of the three different teaching methods on learning, at the conclusion of the course all students were tested with the same fundamentals of biology instrument they had been given upon entry. Students who did not complete the course were excluded from all analyses; the proportion of withdrawals was approximately the same among the three groups.) A one-way analysis of variance was computed on post-test scores and the resultant F was not significant. There was no significant difference among the three groups of students on the exiting level of biology knowledge.

TABLE 3. Fundamentals of Biology Post-test Scores

	Teaching Method			
	Audio-tutorial	Lecture	Television	F Ratio
$\bar{X}$	43.58	43.26	41.27	.43 NS
s.d.	9.56	8.08	10.22	

The growth in biological knowledge of individual students enrolled in audio-tutorial, lecture and television sections was also examined. The pre-test score of each student was subtracted from the post-test score and a one-way analysis of variance was computed for the three groups of students. The resultant F was not significant and there were no significant differences in individual growth in biology knowledge as measured by the Fundamentals of Biology test among the three groups of students.

TABLE 4. Individual Fundamentals of Biology

	Teaching Method			
	Audio-tutorial	Lecture	Television	F Ratio
$\bar{X}$	16.79	16.36	11.09	3.5 NS
s.d.	6.585	6.669	5.775	

In order to determine the effect of student choice of teaching method on achievement, a questionnaire of teaching method characteristics was distributed to students enrolled in the audio-tutorial and lecture sections. It was felt that too small number of students were enrolled in the television course to participate in this phase of the study.

The teaching method characteristics questionnaire was adapted to fit the methods used in the audio-tutorial and lecture sections from a questionnaire created by John Connolly and Thomas Sepe.[1] Nine dimensions of teaching methods were included and students were asked to choose one of two descriptions of each dimension. Each description related either to the audio-tutorial or lecture sections as taught at this College. The questionnaire appears as the Appendix.

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[1] John Connolly and Thomas Sepe, Traditional vs. Self-Instructional Models: The Student's Point of View, (Harford Community College, May 10, 1972), P. 19.

59 or 91% of the students enrolled in the audio-tutorial and 38% or 84% of the students enrolled in the lecture section responded to the questionnaire. Brief descriptions of each characteristic and the percentage of students from both audio-tutorial and lecture sections which preferred each characteristic appear in Table 5.

TABLE 5. Responses to Forced Choice Between Audio-tutorial and Lecture Teaching Method Characteristics by Students Enrolled in Biology 103 Taught by Audio-tutorial and Lecture Teaching Methods

Audio-tutorial Student-Centered Teaching Method Characteristics	Students Enrolled in AT	Students Enrolled in Lecture	Students Enrolled in AT	Students Enrolled in Lecture	Lecture or Traditional Teaching Method Characteristics
Individual Emphasis	66%	40%	34%	60%	Group Emphasis
Self-paced	63%	50%	37%	60%	Group Paced
Variable Time Input	59%	50%	41%	50%	Set Time Input
Learner Initiated Testing	61%	47%	39%	53%	Pre-scheduled Testing
Grading on Achievement of Objectives	74%	52%	26%	48%	Competitive Grading
Learner Controlled	58%	50%	42%	50%	Externally Controlled
Instructor as a Resource	58%	34%	42%	66%	Instructor as a Source
Undefined Semester Length	61%	50%	39%	50%	Defined Semester Length
Specified Course Objective	93%	90%	7%	10%	Unspecified Objectives

In order to determine the effect of student preference of teaching method on performance, students who responded to the teaching methods characteristics questionnaire were divided into four groups:

1. Students enrolled in the audio-tutorial section who preferred the audio-tutorial teaching method characteristics,

2. Students enrolled in the audio-tutorial section who preferred the lecture teaching method characteristics,

3. Students enrolled in the lecture section who preferred the lecture teaching method characteristics,

4. Students enrolled in the lecture section who preferred the audio-tutorial teaching method characteristics.

Preference for a teaching method was defined as choosing six out of the nine questionnaire descriptions which reflected either audio-tutorial (student centered) or lecture (traditional) teaching characteristics. It was evident from the initial analysis of the percentage of students choosing each characteristic which appears in Table 5 that only one characteristic, 'specifying course objectives,' was chosen by nearly all the respondents. Thus, it was not unexpected that only a portion of the respondents could be categorized as having a preference for either the student centered or traditional teaching method.

23 or 39% of the student respondents enrolled in the audio-tutorial section and 18 or 47% of the respondents enrolled in the lecture section preferred one of the two teaching methods.

As measures of performance, both test scores on the fundamentals of biology post-test and growth in fundamentals of biology knowledge (post-test minus pre-test scores) were utilized. T tests were computed separately between scores of students in Groups 1 and 2 and scores of students in Groups 3 and 4. The data appears in Table 6. No significant differences were found between students who preferred the teaching method utilized in their course section and students who preferred the teaching method not utilized in their course section. However, the small number of students available for analysis suggests that this study should be replicated with a larger number of students and, work is on-going in this direction.

TABLE 6: The Effect of Preference for Teaching Method on Performance

Teaching Method Preference			Teaching Method Utilized: Audio-tutorial — Fundamentals of Biology: Post-test	Audio-tutorial — Fundamentals of Biology: Gain	Teaching Method Utilized: Lecture — Fundamentals of Biology: Post-test	Lecture — Fundamentals of Biology: Gain
Audio-tutorial or Student Centered	$\bar{X}$	42	15.94	43.64	17.55
	s.d.	16.32	7.79	11.22	8.86
	N	16	16	11	11
Lecture or Traditional	$\bar{X}$	42.14	16.14	38.14	13.42
	s.d.	7.82	6.31	7.24	5.80
	N	7	7	7	7

There were no significant differences, as measured by the T test, between group and individual scores in groups 1 and 2 and 3 and 4.

In summary, this research demonstrated that:

- The method of instruction (audio-tutorial, lecture or television) utilized in Biology 103 by the present faculty affects student performance in a positive direction and to the same degree.
- Method of instruction did not appear to affect student performance differently whether or not the student preferred that method, although these results must be considered tentative because of small sample size.
- Students enrolled in Biology taught by the audio-tutorial method preferred without exception audio-tutorial or student centered teaching method characteristics.
- Students enrolled in Biology taught by both the audio-tutorial and lecture method preferred, overwhelmingly, that course objectives be specified.
- More than half of the students enrolled in Biology taught by the audio-tutorial or lecture method did not have preference for a method (defined as choosing 6 of the 9 characteristics representative of the audio-tutorial or lecture method of instruction) and did have preference for characteristics representative of both methods of instruction.

In conclusion, it appears that offering various methods of instruction is a viable alternative to the more traditional approach where one method is deemed 'best' and utilized by all. This study has also demonstrated that many students prefer characteristics of both the audio-tutorial and lecture teaching methods which suggests that purity of method might be sacrificed for preference--notably in terms of specifying course objectives.

Please correct mailing address below:

Name:_____

Address:_____

_____

CHARACTERISTICS OF TEACHING METHODS

Before taking Biology 103 had you ever had courses taught by the following teaching methods: (check all which apply)

[ ] Lecture
[ ] Educational TV
[ ] Audio-tutorial

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1. Would you prefer a course in which: (check one)

[ ] the student will work primarily on his own using individualized materials. He will occasionally work with small groups and/or with the course instructor on a one to one basis.

or a course in which:

[ ] the student will work primarily in a large group of persons, listening and responding to the instructor's lectures.

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2. Would you prefer a course in which: (check one)

[ ] the pace of the course will be adjusted to the group. The instructor will make weekly assignments to the class as a whole. Students will be expected to complete these assignments.

or a course in which:

[ ] the student will proceed at his own pace as determined by his ability to master specific tasks. This pace will vary from student to student.

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3. Would you prefer a course in which: (check one)

[ ] a major portion of the required course work will be done on campus using the individualized materials. The time required to complete the material will vary. Outside work, primarily in the form of reading, may be expected.

or a course in which:

[ ] the student will meet with the class for 3 hours per week. Additional work, primarily in the form of reading, may be expected outside of class.

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4. Would you prefer a course in which: (check one)

[ ] exams, a final and possibly a course paper will be utilized to assess the students progress in the course. The exams will be administered at defined dates throughout the semester.

or a course in which:

[ ] exams will be given at the end of each of the 12 course units. A student may take the exams when he feels sufficiently prepared. When a student passes a unit exam at an acceptable level he will proceed to the next unit. A final examination and a course paper will also be required.

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5. Would you prefer a course in which: (check one)

[ ] grades will be based upon the student achieving specified course objectives (including a course paper). Grades of A or B will be assigned when the student demonstrates mastery of the knowledge and skills required by the stated course objectives.

or a course in which:

[ ] grades will be assigned based on the students performance as compared to the performance of his classmates. Grades of A or B will be assigned to approximately the top 25% of the class, grades of C will be assigned to the middle 50% and grades of D and F will be assigned to approximately the lowest 25%.

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6. Would you prefer a course in which: (check one)

[ ] the student will be responsible for his own learning and progress and for meeting the stated course objectives.

or a course in which:

[ ] the student will have to meet certain requirements in a specified time frame set by the instructor to maintain satisfactory progress in the course.

---

7. Would you prefer a course in which: (check one)

[ ] the instructor will be the primary source of information for the student by lecturing and answering questions in a class situation.

or a course in which:

[ ] the instructor will serve as a resource to the student, assisting them when they run into difficulty and suggesting materials and approaches to aid them in meeting course objectives.

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8. Would you prefer a course which: (check one)

[ ] would end in 45 hours (15 weeks)

or a course which:

[ ] was completed when a student reached the course objectives, whenever that might be.

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9. Would you prefer a course in which: (check one)

[ ] course objectives were specified in writing the first day of class.

or a course in which:

[ ] course objectives were not specified.

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